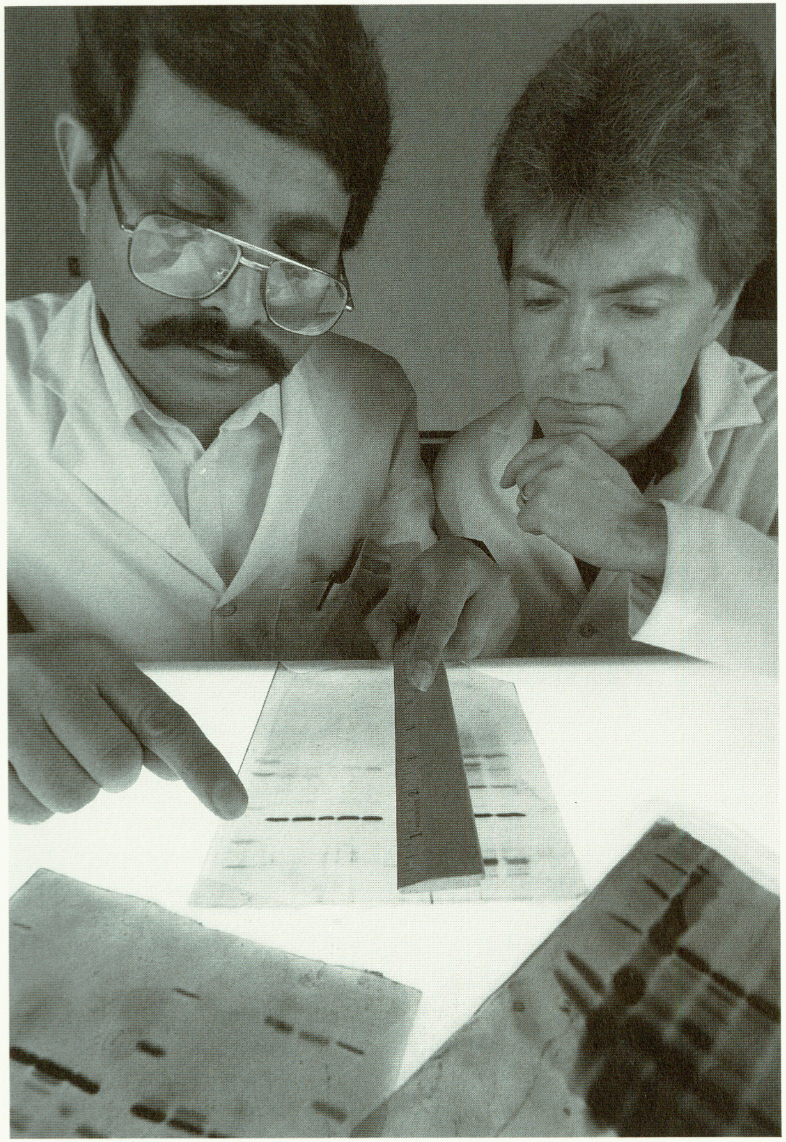
Crop Pest Control

The four regional laboratories did not become seriously involved with controlling weed and insect pests until the 1970's, when diminishing surpluses led to partial redirection of ARS research. Since then, pest control research conducted at many different ARS locations has been augmented by the talents and expertise of the agency's regional lab scientists. One pointed out that "perhaps our biggest surplus in this country is our endless supply of crop pests."

His comment may have been tongue-in-cheek, but he was dead right about the size of the crop pest army. Competing for our food and fiber are 10,000 species of insects, 1,800 weeds, 1,500 kinds of nematodes, and 1,500 plant and animal diseases. If we didn't control them, they would destroy from 30 to 50 percent of our crops every year.

Phytoalexins: A Plant's Defenses

Plants, like humans, possess chemical defenses to protect them from microbial infections. In a plant, an infection may cause what plant physiologists call a hypersensitive response. Such a response may trigger the production of chemicals called phytoalexins to fight the microbial infection. The fact that plants produce phytoalexins only when stressed is evidence that the chemicals are part of the plant's chemical defense mechanism. NRRC researchers are presently using a battery of modern techniques, including computer-based molecular modeling, to determine whether phytoalexins might have potential uses in agriculture or medicine.

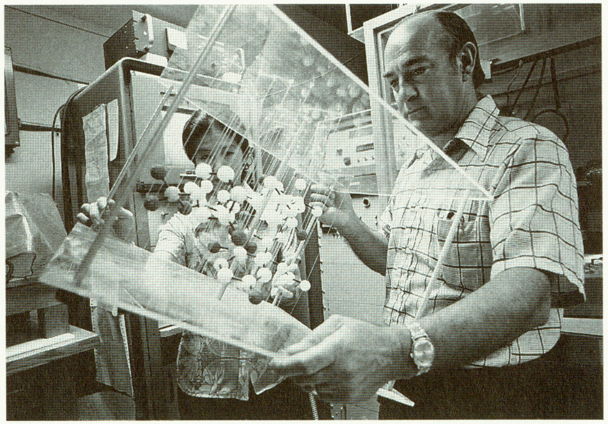


Microbiologist Subhash Gupta (left) and geneticist Timothy Leathers look at data on purified fungal enzymes that may control certain insect pests of vegetables. The Peoria researchers are studying fungi that secrete enzymes that break down an insect's outer "skin," allowing them to penetrate it and consume the pest.

Fungus vs. Fungus

A beneficial fungus was approved in 1990 by the Environmental Protection Agency as a new biological control to fight two fungal plant diseases in greenhouses. The good fungus, a strain of *Gliocladium virens,* is able to reduce by 80 to 95 percent the plant losses caused by the two diseases, which presently cost growers more than $1 billion a year. Greenhouse owners refer to the diseases as damping off. They rot seeds, seedlings, and cuttings. Almost any seedling is vulnerable to attack, and victims include geraniums, snapdragons, chrysanthemums, poinsettias, celosia, cotton, corn, beans, and soybeans. The two bad fungi can destroy 10-30 percent of a crop.

Gliocladium, the good fungus, was isolated from local soil at an ARS laboratory in Beltsville, Maryland. Its dormant spores have been put into pellets, along with wheat bran and alginate—a natural gel-like material that binds the particles together. When the pellets are moistened, the spores germinate and the fungus multiplies and controls the diseases. The alginate pellet formulation was originally developed at the Southern lab. ARS has granted a company an exclusive right to produce the new product, which should be on the market shortly.



WRRC chemists Leonard Jurd and Rosalind Y. Wong examine a molecular model of a naturally occurring larvicide derived from a species of Panamanian tree. The chemical is highly toxic to termites and marine borers.

The female Mediterranean fruit fly is attracted by the aroma of ripe fruit but repelled by the scent of unripe fruit. Western lab chemists hope to synthesize the unripe fruit odor and use it to keep the pest away from ripening fruit.

In the first two decades after World War II, the farmer's favorite method for controlling weeds and insects was to poison them with chemical pesticides. That was usually the most effective and least expensive way to do it. But things went wrong with that approach. Pesticides killed beneficial insects as well as harmful ones. Wind sometimes blew them onto the wrong crops. Some, including persistent chemicals like DDT, concentrated in the food chain. And many insect and weed species grew resistant or even immune to specific pesticides. When that happened, it took new and more potent chemicals to kill them—or bigger doses of the old ones.

As a result of growing disenchantment with wholesale poisoning of crop pests, ARS and other research groups put more and more emphasis on finding biological pest controls. And in those cases where pesticides seemed the only answer, researchers have sought ways to use smaller amounts of poison and to pinpoint delivery to the specific weed or insect under attack.

One way that crop pests can be controlled without poisons is with fungi and fungal derivatives. Researchers in the Northern lab recently discovered a method by which five strains of fungi can be used to kill insects selectively that attack corn, wheat, and other crops. Each fungus secretes enzymes that break down the chitin that forms an insect's exoskeleton, allowing the fungus to penetrate and consume the pest. The researchers plan to isolate the most promising enzymes, using genetic engineering. The aim is commercial production of fungi that can be sprayed on crops. "The great thing about these fungi," says one scientist, "is that they are safe for plants, beneficial insects, people, and the environment. And it's unlikely that insects can develop resistance." These and other biological controls for pests require regulatory approval from the U.S. Environmental Protection Agency.

With our present knowledge, it appears that farmers will have to continue to make careful and sensible use of some chemical pesticides to control weed and insect pests of many crops. Two regional laboratories have invented ways to release such chemicals slowly and at minimum risk to the environment. One method, developed at the Southern lab, mixes a herbicide with a solution of algin, derived from seaweed. Droplets of the mixture are allowed to fall into a gelling solution. Slow-release gel beads form almost at once. The rate at which the herbicide is ultimately released in the field can be slowed even more by drying the beads in small pellets. The algin beads can also be used to encapsulate living biological control agents like fungi to kill weeds that spread crop disease.

Another SRRC process, similar to that used to make pasta, traps fungi or nematodes in granules of wheat dough. Weed-killing fungi grow to cover the granule surface and spread spores that infect and kill weeds. Entrapped nematodes escape when the granules are wet to kill harmful insects in the soil.

Peoria researchers have also encapsulated pesticides, but theirs are contained in a starch matrix. Controlled release reduces losses of pesticides from evaporation. Also, less of a chemical leaches into the soil during rainstorms, and it is protected from decomposition by sunlight. The pesticide in its starch jacket stays where it is targeted.

Bacteria and viruses that kill insect pests are also ideal candidates for starch encapsulation. Live pathogens die quickly in the field and must be protected if they are to be effective control agents. Recently, a Peoria team of scientists found that combining sugar with the starch in an encapsulated spray formula dramatically increased the length of time the formula stays in place to do its work. In one test, the sugar-starch spray adhered to plant foliage for up to 19 days, while formulations without the sugar flaked or peeled off in 2 to 4 days. In another test, the sugar-starch formula greatly increased the killing power of *Bacillus thuringiensis* (Bt), a biological insecticide. The inventors have entered into a cooperative research agreement with a private firm to test the formulation further. They hope to increase the spray's effectiveness while reducing the cost of producing it. (See chapter on "Corn and Wheat Starch," p. 120.)

Searching for Contraband

Day and night, agricultural inspectors at U.S. international airports must check the luggage of incoming passengers for fruits, vegetables, and other plant materials and for certain unprocessed foods. A foreign orange, for example, could contain larvae of the medfly, a costly enemy of citrus. A salami could harbor the organisms of rinderpest or foot-and-mouth disease and trigger a plague that could decimate America's livestock industry. Bringing such products into this country is illegal, of course, but that doesn't stop countless travelers from trying to do it.

WRRC's T. F. Schatzki (right) and Richard Young compare stored TV image of suitcase items with actual contents. The suitcase was opened after it emerged from X-ray scanner. Schatzki is seeking a way to detect contraband without opening every piece of luggage.

To help USDA inspectors with their difficult task, researchers at two regional laboratories have come up with two different systems for screening incoming luggage. One method sniffs; the other looks. Both have been tested successfully at U.S. airports.

A hand-held infrared sniffer gun, developed at the Eastern lab, activates a warning light when it detects high levels of carbon dioxide in a box or suitcase. Fruits and vegetables give off the gas once they have been picked. The sniffer was first tested by inspectors at Los Angeles International Airport to screen luggage of visitors to the 1984 Olympics.

Another experimental method, this one developed at the Western lab, uses X-ray, video, and computer technology to spot suspicious-looking luggage before it gets to the inspector. As a bag is unloaded from a plane, an X-ray picture of what's inside is fed to a computer. The computer, which has been programmed to spot suspicious food shapes, analyzes the bag's contents and stores the information. At the same time, the X-ray image of the bag is displayed on a TV screen, where a brightly colored outline instantly highlights any food shapes recognized by the computer. The X-ray and video can scan bags at the rate of one every 3 seconds.

If the automated system identifies a food shape, the suspect suitcase is coded, alerting inspectors that the luggage should be searched after the traveler picks it up. Inspectors can call up X-ray images of bags being searched so that they will know where to look for suspect contraband. When tested at San Francisco International Airport, the WRRC system spotted such illegal items as coconuts, oranges, fresh mangoes hidden in large tin cans, and partially cooked duck eggs. Their shapes gave them away.